

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM

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The power programs in NASA and DOD are presently structured towards providing the technology for future large space power systems. The synchronous energy technology program is a program to define the technologies required for future geosynchronous power stations and to collect and focus existing and new technology programs towards common structured goals. The output of the program will be a series of design data documents to provide design information and to transfer the technology to the involved community.

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM CONCEPT

- A TECHNOLOGY PROGRAM TO ENABLE GEO, LONG LIFE, POWER (~25 KW, 10 yr)
- PROVIDE FOCUS FOR ADVANCED TECHNOLOGIES
- IDENTIFY NEW TECHNOLOGIES APPLICABLE TO GEO, HIGH POWER REQUIREMENTS
- INITIATE A CONTINUING EFFORT TO FACILITATE TECHNOLOGY TRANSFER

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM SYSTEM BENEFITS

- WITH CURRENT POWER SYSTEM TECHNOLOGY THE STS PERFORMANCE CAPABILITIES CAN POTENTIALLY PLACE A 10-kW POWER SYSTEM IN A GEO ORBIT.
- THE PROGRAM CAN PROVIDE A FOCUS FOR ADVANCED GEOSYNCHRONOUS SPACE POWER TECHNOLOGY EFFORTS.
- INTEGRATION OF THERMAL MANAGEMENT WITH POWER GENERATION PROVIDES SIGNIFICANT BENEFITS. AN INTEGRATED POWER SYSTEM COMBINING THE FUNCTIONS OF POWER GENERATION, DISTRIBUTION AND CONDITIONING WITH THERMAL MANAGEMENT WILL
 - INCREASE PERFORMANCE
 - ENHANCE RELIABILITY
 - REDUCE COMPLEXITY
 - LOWER WEIGHT
- AVAILABILITY OF HIGH POWER IN GEO IS MISSION ENABLING
 - DOD SURVEILLANCE AND DEFENSE
 - COMMUNICATIONS PLATFORMS
 - ADVANCED TERRESTRIAL BENEFITS
- COMMERCIALIZATION OF GEO SPACE WILL REQUIRE CENTRAL POWER STATION GENERATION AND DISTRIBUTION TECHNOLOGY.

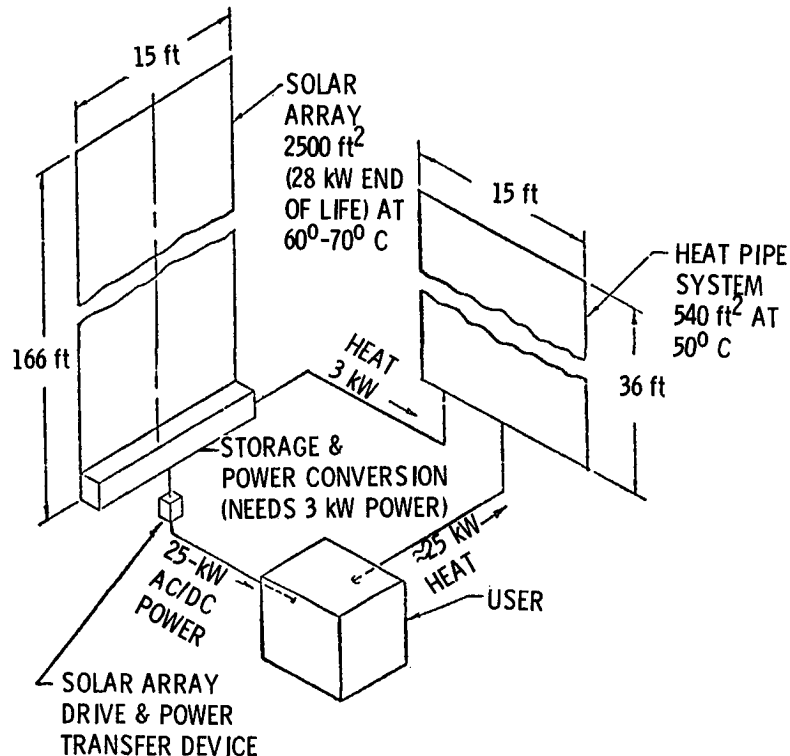
SET SYSTEM ASSUMPTIONS

- FREE FLYER
- GEO
- 10-YEAR LIFE
- DELIVER 25 kW AC/DC POWER TO USER (EOL)
- DISSIPATE 25 kW OF HEAT FROM THE USER
- DISSIPATE ~3 kW OF POWER CONVERSION LOSSES
- USER DOCKING FACILITY
- SHUTTLE - IUS LAUNCH (2269 kg)
- TECHNOLOGY READY IN 5 YEARS
- BATTERY STORAGE CAPACITY $\approx 2\text{-}1/2$ kW hr PEAK POWER ≈ 50 kW
- DEPLOYMENT AT GEO

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM
SYSTEM CONCEPTUAL DESIGNS

- ARRAY BLANKETS MAY INCORPORATE INTEGRAL THERMAL CONTROL FOR RADIATION OF POWER DISTRIBUTION AND USER THERMAL LOSSES.
SIMPLE STANDARDIZED THERMAL UMBILICAL
- CAPABILITY FOR PROVIDING REGULATED, CONTROLLED POWER FOR A VARIETY OF USER REQUIREMENTS.
STANDARDIZED VOLTAGE AND FREQUENCY WILL BE PROVIDED TO ALL USERS FOR PLUG-IN OPERATION. ADAPTABLE POINT OF LOAD (POL) CONVERTERS CAN THEN BE DEVELOPED TO MEET MULTIPLE USER REQUIREMENTS.
- INTEGRAL ARRAY/POWER CONVERSION/STORAGE SIMPLIFIES POWER MANAGEMENT INTERFACES.
POWER CONVERSION ON THE ARRAY SIMPLIFIES ROTARY POWER TRANSFER REQUIREMENTS.
INTEGRAL ARRAY/POWER CONVERSION REDUCES TRANSMISSION LINE LOSSES.

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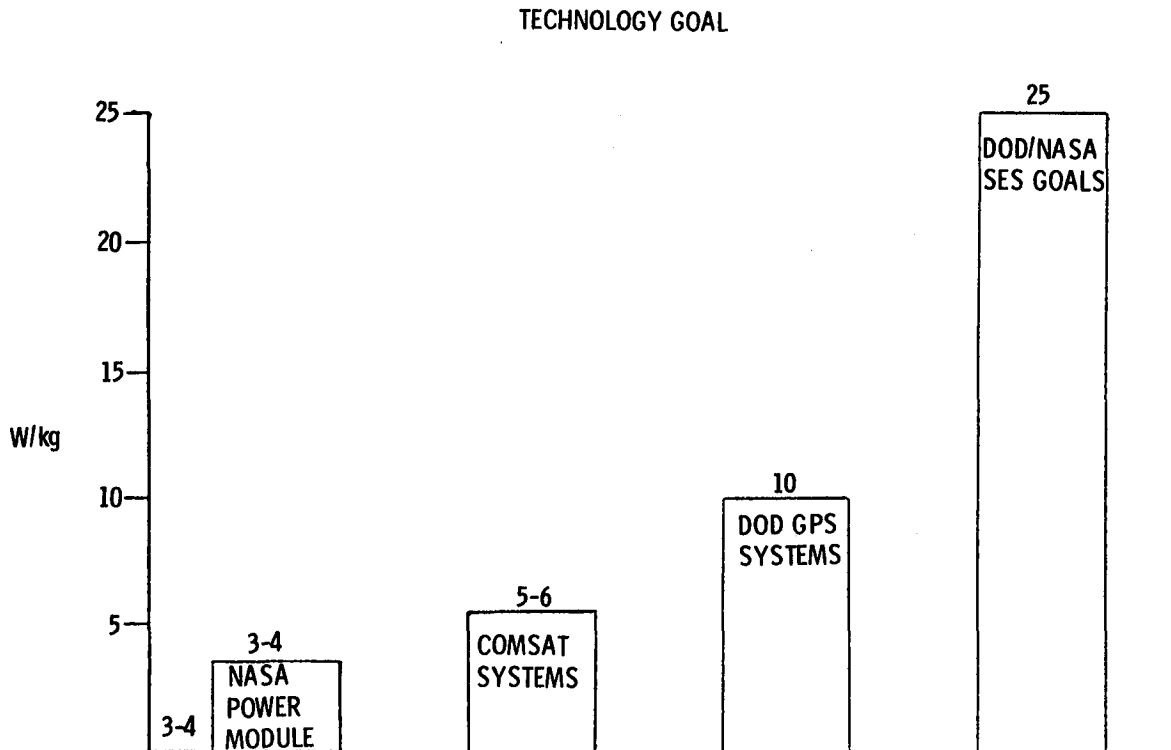


SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM
SYSTEM TECHNOLOGY GOALS

TO PROVIDE TECHNOLOGY FOCUS, A 25-KW, GEO FREE, FLYER POWER STATION WITH A GOAL OF AT LEAST 2.5-KW hr AND 28-KW HEAT REJECTION CAPABILITY, COMPATIBLE WITH SHUTTLE/IUS WILL BE BASELINE REQUIREMENTS.

TO ATTAIN TECHNOLOGY GOALS, ADVANCES REQUIRED ARE

- (1) REPLACE NiCd BATTERIES WITH LONG-LIFE, HIGH-ENERGY-DENSITY STORAGE SYSTEM.
- (2) REPLACE 28 V dc SYSTEM WITH HIGH VOLTAGE AC/DC DISTRIBUTION BUS.
- (3) ADDRESS INTEGRATING SEPARATE SOLAR ARRAY THERMAL CONTROL SYSTEM WITH INTEGRAL THERMAL CONTROL.
- (4) INCREASE SYSTEM SPECIFIC POWER TO BE COMPATIBLE WITH STS CAPABILITIES FOR 25 KW IN GEO.
- (5) RADIATION HARDENING.
- (6) REPLACE CURRENT RETROFITTED POWER SYSTEM CONTROLS WITH INTEGRATED AUTONOMOUS FAULT PROTECTION SYSTEM.



SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM

CANDIDATE SPECIFIC PROGRAM ELEMENTS:

- (1) INTEGRAL SOLAR ARRAY/POWER CONVERSION AND THERMAL CONTROL SYSTEM
- (2) HIGH VOLTAGE TRANSMISSION AND DISTRIBUTION (AC AND/OR DC)
- (3) HIGH POWER ROTARY TRANSFER DEVICE
- (4) POINT OF LOAD POWER CONVERSION
- (5) SYSTEM/ENVIRONMENT INTERACTION CONTROL
- (6) SOLAR ARRAY BLANKET/MATERIALS TECHNOLOGY
- (7) APPLICATION OF ADVANCED STORAGE TECHNOLOGY
- (8) STRUCTURAL/THERMAL/ELECTRICAL COMPOSITE MATERIAL TECH.
- (9) LONG LIFE THERMAL CONTROL TECHNOLOGY
- (10) HIGH TEMPERATURE ELECTRONICS
- (11) SOLAR ARRAY CONCENTRATOR TECHNOLOGY
- (12) RADIATION HARDENING
- (13) AUTONOMOUS ENABLING SUBSYSTEMS
- (14) THERMAL ENERGY TRANSFER
- (15) SOLAR ARRAY THERMAL CHARACTERISTICS

SYNCHRONOUS ENERGY TECHNOLOGY PROGRAM

OBJECTIVE: TO DEVELOP AND EXECUTE A FOCUSED TECHNOLOGY PROGRAM TO PRODUCE A DESIGN DATA BASE FOR FUNCTIONALLY INTEGRATED GEOSYNCHRONOUS ORBIT, SPACE POWER.

APPROACH: CONDUCT CONTRACT AND IN-HOUSE SYSTEMS AND TECHNOLOGY EFFORTS FOR A PROGRAM WHICH ALLOWS THE INTEGRATION OF THE MAJOR SUBSYSTEMS FOR SPACE POWER AND INCORPORATES THE TECHNOLOGIES REQUIRED WHICH ARE ENABLING OR CAN BE SHOWN TO BE COST EFFECTIVE OVER THE TOTAL MISSION LIFE CYCLE.

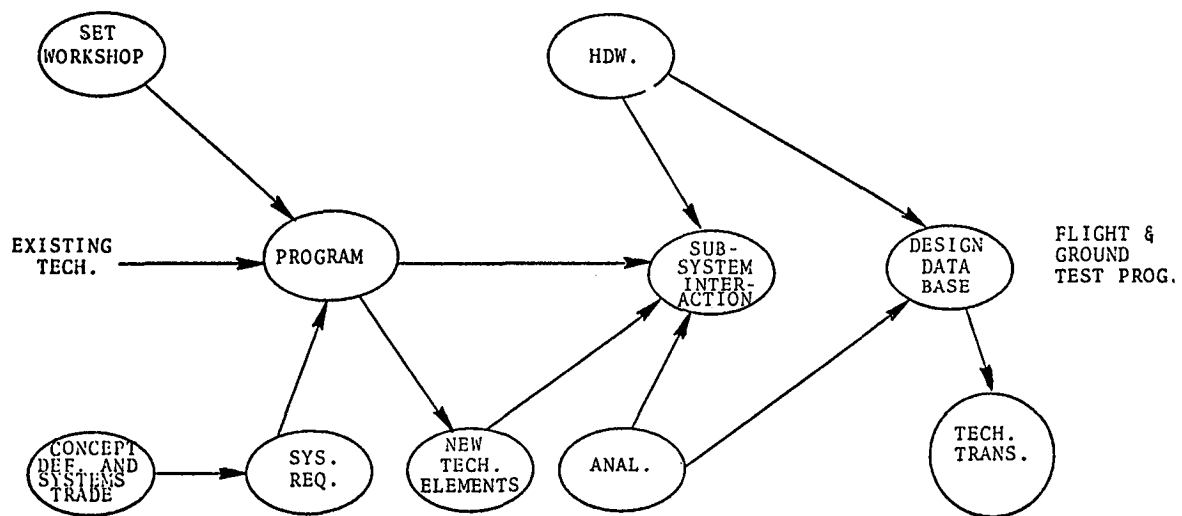
TECHNICAL MANAGEMENT APPROACH

REVIEW EXISTING TECHNOLOGY PROGRAMS AND THEIR POTENTIAL APPLICABILITY TO THE HIGH ORBIT SPACECRAFT ENERGY TECHNOLOGY PROGRAM.

SYSTEM TRADEOFFS PERFORMED ON SUBSYSTEM APPROACHES OF THE HIGH ORBIT SPACECRAFT ENERGY TECHNOLOGY SYSTEM PROGRAM WILL PROVIDE REQUIREMENTS FOR FOCUSSED THE EXISTING TECHNOLOGIES AND IDENTIFY THE NEW TECHNOLOGY ELEMENTS NEEDED.

SUBSYSTEM INTERACTION DATA BASED ON HARDWARE AND ANALYSIS WILL DETERMINE NEEDS FOR THE TECHNOLOGY VERIFICATION PROGRAM.

TECHNICAL MANAGEMENT APPROACH



SUMMARY OF ENERGY STORAGE TECHNOLOGY REQUIREMENTS

- ENERGY STORAGE CAN BE SINGLE HEAVIEST ELEMENT OF POWER SYSTEM
- REDUCE POWER TO 10% IN ECLIPSE BECAUSE OF WEIGHT OF BATTERIES REQUIRED FOR 100% POWER IN ECLIPSE.
- BATTERY TECHNOLOGY MUST ADVANCE FROM 18 (W hr)/kg TO 55 (W hr)/kg EVEN FOR REDUCED REQUIREMENT.